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ECLIPSES OF *JUPITER'S* SATELLITES, P. S. T.

(Off right-hand limb as seen in an inverting telescope.)

II,	D,	Nov.	1,	$7^h 33^m$ P.M.	II,	R,	Dec.	3,	$7^h 26^m$ P.M.
I,	R,		3,	7 57	I,	R,		5,	4 36
IV,	D,		4,	6 44	I,	R,		12,	6 31
IV,	R,		4,	11 28	III,	D,		19,	1 41
III,	R,		6,	5 5	III,	R,		19,	5 13
II,	R,		8,	10 12	I,	R,		19,	8 26
I,	R,		10,	9 53	II,	R,		21,	2 2
I,	R,		12,	4 21	I,	R,		21,	2 55
III,	D,		13,	5 34	III,	D,		26,	5 42
III,	R,		13,	9 6	III,	R,		26,	9 14
I,	R,		19,	6 17	II,	R,		28,	4 41
III,	D,		20,	9 35	I,	R,		28,	4 50
IV,	R,		21,	5 40					
II,	R,		26,	4 48					
I,	R,		28,	2 41					

THE SEARCH FOR AN INTRA-MERCURIAL PLANET AT THE TOTAL SOLAR ECLIPSE OF 1901, MAY 18.

By C. D. PERRINE.

The considerable motion of the line of apsides of *Mercury's* orbit, found by LEVERRIER and others, cannot be explained by the attraction of the known bodies in the system, but would be fully accounted for by a planet or ring of planets between *Mercury* and the Sun.

The question is one which has attracted more or less attention from astronomers for over a century, and announcements have been made at various times of the supposed discoveries of such bodies. None of these announcements have ever been verified, however.

The solution of the problem is of peculiar difficulty. The necessary observations are possible only during the few minutes of a total eclipse, when the Sun's disk is entirely hidden. At any other time it would be impossible to detect an object very much fainter than *Mercury*.

The early searches at total eclipses were all made visually, and it was necessary to memorize the position and brightness of all the brighter stars in the region to be examined. The liability to mistake in the identification of stars was thus very great. Several of the supposed discoveries are probably due to this cause.

Searches by visual methods at a number of eclipses rendered it almost certain that there were no such bodies as bright as the third, and possibly the fourth, magnitude. But as to fainter objects there was no evidence whatever.

Since the introduction of the rapid dry-plate into astronomical work, it has become possible to attempt an adequate search for such bodies.

The first attempt, to my knowledge, to solve this problem with cameras of considerable focal length was during the eclipse of May 28, 1900. No definite results seem to have been obtained at that eclipse, however.

The great duration of totality (6½ minutes) in 1901 was very favorable for an intra-Mercurial planet search. The observations made in Sumatra for this purpose were described in the account of the Crocker Expedition from the Lick Observatory, published in No. 81 of the *Publications*. A re-examination of these plates has just been completed under more favorable conditions and has resulted in finding many fainter stars and some star-images on all of the plates.

Following is a summary of the results of the examination:—

No. of Plates.	STAR IMAGES.			REMARKS.
	Original Search.	Added by Re-examination.	Total Number.	
A_1 B_1	29	21	50	Faintest stars = one each of 9.1, 9.2, and 9.3 visual magnitude.
C_1 D_1	37	14	51	Faintest stars = two each of 8.6 and 9.0 visual magnitude.
A_2 B_2	26	9	35	Faintest stars = one each of 8.7 and 8.8 visual magnitude.
C_2 D_2	0	26	26	Faintest stars = three of 8.3, one each of 8.6 and 8.7 visual magnitude.
A_3 B_3	0	3	3	One star each of 6.0, 6.2, and 6.5 visual magnitude. *Mercury* and *Venus* are bright objects on the plates.
C_3 D_3	0	5	5	One star each of 4.0, 5.2, and 6.5 visual magnitude and two of 6.0 visual magnitude.
Total.	92	78	170	

Four out of the six regions covered by the photographs show stars from 8.7 to 9.3 visual magnitude. These were the first two sets of exposures. The clouds became thicker toward the end of totality, so that the set of exposures made then fails to show as faint stars. They, however, contain stars from 6.0 to 6.5 magnitude. Only two stars in the entire region, which were brighter than 6.0 visual magnitude, failed to record themselves on all of the plates. One of these was 5.0, the other 5.1 visual magnitude. According to the Draper Catalogue, the photographic magnitudes of these stars are 5.2 and 6.1, the former being a red star.

As the faintest stars recorded on the negatives are those which, in general, are more strongly actinic than a planetary body, it is necessary to make some allowance for this difference in deducing the limiting (visual) magnitude of the search. It seems probable that this difference would usually not exceed one magnitude. Hence if all the stars of 6.0 visual magnitude were recorded on the plates, a planet of 5.0 magnitude should be visible. The same criterion would indicate that in two thirds of the region searched, where stars of 8.7 to 9.3 magnitude were photographed, a planet as bright as 7¾ or 8.0 magnitude should have been recorded.

There is therefore little probability that any planet as bright as 5.0 magnitude exists in the region searched. While the clouds prevented the search from being definite to a much fainter magnitude, it is hardly possible that a ring of planets as bright as 8th magnitude can exist without some of them having been found.

From observations of the brightness of the four principal asteroids made at Harvard College Observatory and the measures of their diameters made by BARNARD at the Lick Observatory, it is found that such a body 300 miles in diameter appears on the average as a star of the 8.0 magnitude when seen from the Earth at opposition. If such a body were removed to the greatest probable distance from the Sun of an intra-Mercurial planet, it would appear to an observer on the Earth more than 110 times as bright, a difference of over five magnitudes. Hence we find that an intra-Mercurial planet to be of 5.0 magnitude would have to be only 75 miles in diameter, and one of 8.0 magnitude but 30 miles in diameter.

The perturbations in the motion of *Mercury* would require a mass of matter about half as great as that of the planet itself. It would therefore take one million intra-Mercurial planets 30 miles in diameter, and as dense as *Mercury*, to cause the observed disturbances.

The observations made at this eclipse, although very much interfered with by the clouds, indicate that there are probably no bodies of appreciable size in the region close about the Sun, and that the cause of the disturbance in the motion of *Mercury* must be sought elsewhere.

The suggestion has also been made that these perturbations might be caused by a ring of bodies between *Mercury* and *Venus*. If this were true, it would seem that some effect should be observed in the motion of *Venus*.

Perhaps the finely divided matter composing the Zodiacal Light may be sufficient to cause these perturbations.

MT. HAMILTON, CALIFORNIA, August 27, 1902.